

AMENDMENTS TO THE CLAIMS

1-5. (Canceled)

6. (Currently Amended) A battery charging apparatus which charges a battery, comprising:

a voltage detecting circuit arranged and configured to detect a battery voltage of said battery and for outputting a signal in response to a detected battery voltage;

a current detecting circuit arranged and configured to detect a charging current supplied to said battery and for outputting a signal in response to a detected charging current;

a charging circuit arranged and configured to control said charging current such that said detected battery voltage increases to become substantially equal to a first pre-set voltage in response to a first input control signal and also such that said detected charging current becomes substantially equal to a constant current predetermined in response to a second input control signal; and

a charge control circuit that instructs said charging circuit by said first and said second input control signals to set said first pre-set voltage and said constant current in response to said signal from said voltage detecting circuit.

wherein the charge control circuit is arranged and configured to instruct the charging circuit to perform constant current charging to flow a first constant current to the battery and subsequently to flow a second constant current greater

than the first constant current to the battery when the detected battery voltage of the battery is smaller than a second pre-set voltage, and to instruct the charging circuit to perform pulse charging, in which flowing current to said battery and pausing current flow to said battery are alternately performed at intervals of a pre-determined time period,

wherein the charge control circuit instructs the charging circuit to control the charging current flowing to the battery such that a charging voltage applied across said battery becomes substantially equal to a third constant voltage during the constant current charging during the pulse charging and also such that the charging voltage becomes substantially equal to a first constant voltage smaller than the third constant voltage during the pausing in the pulse charging, and

~~The battery charging apparatus as defined in Claim 3,~~ wherein the charge control circuit instructs the charging circuit to control the charging current flowing through the battery such that the charging voltage becomes substantially equal to the first constant voltage when the battery voltage is smaller than the first pre-set voltage which is smaller than the second pre-set voltage and also such that the charging voltage becomes substantially equal to the second constant voltage which is less than the third constant voltage and greater than the first constant voltage, during the constant current charging before the pulse charging is executed.

7. (Currently Amended) A battery charging apparatus which charges a battery, comprising:

a voltage detecting circuit arranged and configured to detect a battery voltage of said battery and for outputting a signal in response to a detected battery voltage;

a current detecting circuit arranged and configured to detect a charging current supplied to said battery and for outputting a signal in response to a detected charging current;

a charging circuit arranged and configured to control said charging current such that said detected battery voltage increases to become substantially equal to a first pre-set voltage in response to a first input control signal and also such that said detected charging current becomes substantially equal to a constant current predetermined in response to a second input control signal; and

a charge control circuit that instructs said charging circuit by said first and said second input control signals to set said first pre-set voltage and said constant current in response to said signal from said voltage detecting circuit.

wherein the charge control circuit is arranged and configured to instruct the charging circuit to perform constant current charging to flow a first constant current to the battery and subsequently to flow a second constant current greater than the first constant current to the battery when the detected battery voltage of the battery is smaller than a second pre-set voltage, and to instruct the charging circuit to perform pulse charging, in which flowing current to said battery and pausing current flow to said battery are alternately performed at intervals of a pre-determined time period,

wherein the charge control circuit instructs the charging circuit to control the charging current flowing to the battery such that a charging voltage applied

across said battery becomes substantially equal to a third constant voltage during the constant current charging during the pulse charging and also such that the charging voltage becomes substantially equal to a first constant voltage smaller than the third constant voltage during the pausing in the pulse charging,

wherein the charge control circuit instructs the charging circuit to control the charging current flowing through the battery such that the charging voltage becomes substantially equal to the third constant voltage during the constant current charging before the pulse charging is executed, and

~~The battery charging apparatus as defined in Claim 5,~~ wherein the charging circuit further comprises:

a constant voltage generating circuit that generates said first, second, and third constant voltages;

a voltage switching circuit that selects and outputs one of the first and third constant voltages output from the constant voltage generating circuit in accordance with the control signals from the charge control circuit;

a control transistor that outputs a current to the battery in response to a control signal input to the control transistor; and

a control circuit that controls the control transistor such that the battery voltage represented by a signal output from the voltage detecting circuit becomes substantially equal to a voltage represented by a signal output from the voltage switching circuit and that the charging current represented by a signal output from the current detecting circuit becomes

substantially equal to a constant current represented by a signal output from the a signal switching circuit arranged and configured to supply signals to said control circuit.

8. (Previously Presented) The battery charging apparatus as defined in Claim 6, wherein the charging circuit further comprises:

a constant voltage generating circuit that generates the first, second, and third constant voltages;

a voltage switching circuit that selects and outputs one of the first and third constant voltages output from the constant voltage generating circuit in accordance with the control signals from the charge control circuit;

a control transistor that outputs a current to the second battery in response to a control signal input thereto; and

a control circuit that controls the control transistor such that the battery voltage represented by a signal output from the voltage detecting circuit becomes substantially equal to a voltage represented by a signal output from the voltage switching circuit and that the charging current represented by a signal output from the current detecting circuit becomes substantially equal to a constant current represented by a signal received from a signal switching circuit.

9-10. (Canceled)

11. (Previously Presented) The battery charging apparatus as defined in Claim 7, wherein the current detecting circuit comprises:

a resistor through which the charging current to be supplied to the battery flows; and

a current detector that detects the charging current based on a voltage across the resistor and outputs a signal in response to the detected charging current,

wherein the voltage detecting circuit, the current detector of the current detecting circuit, the charge control circuit, a charge-end detecting circuit, and several components of the charging circuit including a constant voltage generating circuit, a voltage switching circuit, a constant current reference signal generating circuit, a signal switching circuit, and a control circuit are integrated into a single integrated circuit chip.

12. (Previously Presented) The battery charging apparatus as defined in Claim 8, wherein the current detecting circuit comprises:

a resistor through which the charging current to be supplied to the battery flows; and

a current detector that detects the charging current based on a voltage across the resistor and outputs a signal in response to the detected charging current,

wherein the voltage detecting circuit, the current detector of the current detecting circuit, the charge control circuit, a charge-end detecting circuit, and several components of the charging circuit including a constant voltage generating circuit, a voltage switching circuit, a constant current reference signal generating circuit, a signal switching circuit, and a control circuit are integrated into a single integrated circuit chip.

13-18. (Canceled)

19. (Previously Presented) The charging method as defined in Claim 16, wherein the charging current to the battery is controlled such that the charging voltage of the battery becomes substantially equal to the first constant voltage when the battery voltage of the battery is smaller than the first pre-set voltage during the first constant current charging and such that the charging voltage of the battery becomes substantially equal to a second constant voltage smaller than the third constant voltage and greater than the first constant voltage during the first constant current charging.

20-27. (Canceled)

28. (Previously Presented) The battery charging apparatus as defined in Claim 25, wherein the charge control circuit instructs the charging circuit to control the charging current flowing through the battery such that the charging voltage becomes

substantially equal to the first constant voltage when the battery voltage is smaller than the first pre-set voltage which is smaller than the second pre-set voltage and also such that the charging voltage becomes substantially equal to the second constant voltage which is less than the third constant voltage and greater than the first constant voltage, during the constant current charging before the pulse charging is executed.

29. (Previously Presented) The battery charging apparatus as defined in Claim 27, wherein the charging circuit further comprises:

a constant voltage generating circuit that generates said first, and third constant voltages;

a voltage switching circuit that selects and outputs one of the first and third constant voltages output from the constant voltage generating circuit in accordance with the control signals from the charge control circuit;

a control transistor that outputs a current to the battery in response to a control signal input to the control transistor; and

a control circuit that controls the control transistor such that the battery voltage represented by a signal output from the voltage detecting circuit becomes substantially equal to a voltage represented by a signal output from the voltage switching circuit and that the charging current represented by a signal output from the current detecting circuit becomes substantially equal to a constant current represented by a signal output from a signal switching circuit arranged and configured to supply signals to said control circuit.



30. (Previously Presented) The battery charging apparatus as defined in Claim 28, wherein the charging circuit further comprises:

a constant voltage generating circuit that generates the first, and third constant voltages;

a voltage switching circuit that selects and outputs one of the first and third constant voltages output from the constant voltage generating circuit in accordance with the control signals from the charge control circuit;

a control transistor that outputs a current to the battery in response to a control signal input thereto; and

a control circuit that controls the control transistor such that the battery voltage represented by a signal output from the voltage detecting circuit becomes substantially equal to a voltage represented by a signal output from the voltage switching circuit and that the charging current represented by a signal output from the current detecting circuit becomes substantially equal to a constant current represented by a signal received from a signal switching circuit.

31-32. (Canceled)

33. (Previously Presented) The battery charging apparatus as defined in Claim 28, wherein the current detecting circuit comprises:

a resistor through which the charging current to be supplied to the battery flows; and

a current detector that detects the charging current based on a voltage across the resistor and outputs a signal in response to the detected charging current,

wherein the voltage detecting circuit, the current detector of the current detecting circuit, the charge control circuit, a charge-end detecting circuit, and several components of the charging circuit including a constant voltage generating circuit, a voltage switching circuit, a constant current reference signal generating circuit, a signal switching circuit, and a control circuit are integrated into a single integrated circuit chip.

34. (Previously Presented) The battery charging apparatus as defined in Claim 30, wherein the current detecting circuit comprises:

a resistor through which the charging current to be supplied to the battery flows; and

a current detector that detects the charging current based on a voltage across the resistor and outputs a signal in response to the detected charging current,

wherein the voltage detecting circuit, the current detector of the current detecting circuit, the charge control circuit, a charge-end detecting circuit, and several components of the charging circuit including a constant voltage generating circuit, a voltage switching circuit, a constant current reference signal generating circuit, a signal switching circuit, and a control circuit are integrated into a single integrated circuit chip.